

APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR(S): Nobuyuki NAKAJIMA

INVENTION: IMAGE PROCESSING METHOD OF
GENERATING CONVERSION DATA
FOR A SCANNER AND
CALIBRATION METHOD
EMPLOYING THE SCANNER

S P E C I F I C A T I O N

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This application is based on Japanese Patent Application Nos. 11-263920 and 11-264634 both filed September 17, 1999, the content of which is incorporated hereinto by reference.

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BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

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The present invention relates to an image processing method of generating conversion data for a scanner, and to a calibration method of calibrating a printing apparatus by means of the scanner.

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DESCRIPTION OF THE PRIOR ART

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It is generally known that a printing property of a printing apparatus may vary according to a surrounding condition such as a temperature and a humidity of a surrounding air, in which the printing apparatus is used. Not only the surrounding condition but also use of the printing apparatus for a certain period of time may cause the printing property to vary. In a case of electro-

25 photographic printing apparatus, for instance, a photosensitive property of a photosensitive drum changes according to the surrounding condition and to aging by the

disposed, and causes a densitometer, a scanner or others to read the printed chart. Then, based on read data, the user makes, for example, contents of a density correction table used in the image processing for generating printing data renewed. Accordingly, in order to carry out the calibration of the printing apparatus with high accuracy, it is also important to read the chart printed by the printing apparatus correctly.

As a device for reading the chart, there is known the densitometer. The densitometer gives so-called device-independent data such as CIE-1931XYZ color system data, $L^*a^*b^*$ system data or the like (hereinafter the data is called "density") as a result of measuring the chart. This allows the density obtained by measuring the chart to correctly reflect the printing property of the printing apparatus which prints the chart, irrespective of the device used for measurement. The densitometer, however, is relatively expensive; it is not realistic to supply a printer with an expensive densitometer as peripheral equipment, or to make the user purchase the densitometer separately in order to calibrate a low-price printer.

On the other hand, in order to read the chart, a scanner which is a device to input an image and others, or a reading portion of a copying machine have been used, conventionally. However, it is difficult to use the scanner and others as a highly accurate device for reading the chart, as the densitometer. This is because conventionally a

calibration for the scanner and others has not been done so as to be able to conduct the highly accurate density measurement. More specifically, it is relatively difficult to generate a table for converting brightness data obtained by the scanner into the density (hereinafter the conversion is called "brightness-density conversion") with high accuracy.

In addition, when the calibration of the scanner and others can not be carried out with high accuracy, different types of scanners and others may become to have different properties. Then, when such scanners are used for the calibration of the printer, different colors may be reproduced among printers.

SUMMARY OF THE INVENTION

An object of the present invention is to make it possible to carry out a calibration of reading means such as a scanner, which is used as a densitometer, always with high accuracy.

Another object of the present invention is to make it possible to generate dynamically a brightness-density conversion table for the reading means in the calibration of the reading means so that not only a fixed type of apparatus but all types of apparatus may be employed as the reading means.

Still another object of the present invention is to

reduce a load owed by a user, which is required for the calibration of the reading means as much as possible.

In the first aspect of the present invention, there is provided an image processing method of generating a conversion condition for a scanner which is used for
5 reading an image and generating image data, the method comprising the steps of:

obtaining a reading property of an object scanner based on image data obtained by that the object scanner
10 reads a chart; and

generating the conversion condition for the object scanner based on the reading property of the object scanner, a previously prepared reading property of a standard scanner and a previously prepared brightness-density
15 conversion condition for the standard scanner.

In a second aspect of the present invention, there is provided an image processing method of generating a correction condition for a scanner used when calibrating a correction condition for image forming means; the method
20 comprising the steps of:

holding a correction condition for a standard scanner;
judging as to whether the scanner used for calibration is the standard scanner or not;

executing generation of the correction condition for
25 the scanner when the scanner is not judged to be the standard scanner; and

not executing generation of the correction condition

for the scanner when the scanner is judged to be the standard scanner.

In a third aspect of the present invention, there is provided an image processing apparatus for generating a conversion condition for a scanner which is used for reading an image and generating image data, the apparatus comprising:

means for obtaining a reading property of an object
scanner based on image data obtained by that the object
10 scanner reads a chart; and

generating means for generating the conversion condition for the object scanner based on the reading property of the object scanner, a previously prepared reading property of a standard scanner and a previously prepared brightness-density conversion condition for the standard scanner.

In a fourth aspect of the present invention, there is provided an image processing apparatus comprising:

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        generating means for generating a correction
20  condition for a scanner used when calibrating a correction
    condition for image forming means;

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holding means for holding a correction condition for a standard scanner; and

judging means for judging as to whether the scanner
25 used for calibration is the standard scanner or not;

wherein the generating means executes generation of the correction condition for the scanner when the scanner

is not judged to be the standard scanner, and the generating means does not execute generation of the correction condition for the scanner when the scanner is judged to be the standard scanner.

5 In a fifth aspect of the present invention, there is provided a calibration method of performing a calibration for a printing apparatus, the method comprising the steps of:

preparing a reading device for reading a predetermined
10 image printed by the printing apparatus;

executing the calibration by renewing brightness-density conversion data obtained based on a reading property of the reading device, a previously prepared predetermined reading property and a previously prepared brightness-density conversion condition corresponding to
15 the predetermined reading property; and

measuring density of the predetermined image by means of the reading device which has been subject to calibration by the calibration step; and

20 generating calibration data for the calibration for
the printing apparatus based on a result of measurement
in the measuring step.

In a sixth aspect of the present invention, there is provided an information processing apparatus for performing a calibration for a printing apparatus, the apparatus comprising:

reading control means for controlling a reading device

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described
5 in detail below with reference to the attached drawings.

In the embodiments described below, a Color Laser Beam
Printer (LBP) is used as an example of a printing apparatus
constituting a system, but needless to say, the present
invention can be applied to other printing apparatuses such
10 as a Color Ink Jet Printer.

<First Embodiment>

Fig. 1 is a block diagram showing a configuration of
a print system according to a first embodiment of the
15 present invention.

Although in this example a connection form and a
protocol in a network as shown in Fig. 1 are not referred
to in detail, the present invention may be applied to any
connection form or protocol.

20 The numeral 1 represents a server PC (Personal
Computer), in which software for realizing the system of
the embodiment is installed. The server PC 1 is connected
to a network 5.

The numeral 11 represents a scanner calibration data
25 storing section, which is provided in the server PC 1 to
store scanner calibration data described below. The
numeral 111, within the scanner calibration data storing

section 11, represents an object scanner brightness-density conversion table storing section for storing a brightness-density conversion table, which is provided for a scanner which a user employs in this print system
5 (hereinafter "object scanner") and which is used upon inputting data read by the object scanner. The numeral 112, within the scanner calibration data storing section 11, represents a standard scanner brightness-density conversion table storing section which stores a
10 brightness-density conversion table for a standard scanner made in advance, for example, in a manufacturing stage of this system. The numeral 113, within the scanner calibration data storing section 11, represents a standard scanner property data storing section which stores
15 property data of the standard scanner obtained by that the standard scanner reads a scanner chart in advance. In a scanner calibration described later, newly obtained other information as well as the data previously prepared in the standard scanner brightness-density conversion table
20 storing section 112 and the standard scanner property data storing section 113 are made used together, so that the data in the object scanner brightness-density conversion table storing section 111 is generated finally.

The numeral 2 represents a printer connected to the
25 network 5, which is an apparatus subject to a printer calibration in the system. The printer 2 is constituted so as to be able to print in accordance with an instruction

4B and that the range of normalization for the detected brightness and the read density value is not to the range of 0-255.

Then at step S34 the object scanner brightness-density
5 conversion table is generated. As shown in Fig. 6, this
table can be obtained by combining the standard scanner
brightness-density conversion table 5A obtained in the
previous step S33 and the inter-scanner brightness
correspondence table 5E obtained in step S32. Fig. 5F is
10 a diagram showing an example of the table 5F.

The above-mentioned processes of steps S30-S34 finally generate the brightness-density conversion table 5F for the scanner 3, which is the object scanner, dynamically, and then stores the generated table in the object scanner brightness-density conversion table storing section 111 in the server PC 1. As a result, the scanner 3, which is the object scanner, is used for reading the chart printed out by the printer 2 and the brightness data obtained by reading is converted by using the brightness-density conversion table, when executing the calibration for the printer described below, so that it becomes possible to use the scanner 3 as an apparent densitometer, as shown in Fig. 6.

When the input property of the scanner changes, or when
25 different types of scanners are employed for the system,
it becomes possible to obtain a universal brightness-
density conversion relation by conducting the scanner

inside the arrow allows the user to discriminate that the chart is a printer chart.

The numerals 64, 65, 66 in Figs. 8A and 8B represent registration marks for detecting whether the chart is placed correctly on the manuscript table of the scanner.

The printer chart is output from the printer 2 based on the instruction through the network from the server PC 1 as described above, however it may be possible to have the printer 2 possess the information of constituting the patch data of the format and to generate the patch data based on the information according to the instruction from the PC 1, or to generate the patch data by sending the patch data constitution information to the printer 2 from the PC 1. The patch data constitution information is dependent on a command system possessed by the printer 2, but will not be mentioned here.

After the patches are printed as described above, at step S42 the density of the output patches is measured by means of the scanner 3. More specifically, the scanner 3 generates a brightness signal value of R, G, B concerning each patch and gives the value to the PC 1. On receiving input values, the PC 1 calculates the average of input values of four points for the highlight side and the average of input values of eight points for the shadow side, based on the arrangement of the blocks of the patch, and thereby obtains 48 gradations of R, G, B signal values for each color of C, M, Y, K. These R, G, B brightness signals are

an image processing in the printer 2 as described later referring to Fig. 12.

At step S44 the server PC 1 downloads the calibration table data obtained as described above to the printer 2 through the network, and then completes the process. In the downloading, the sever PC specifies the object printer supposing the case in which a plurality of printers are connected through the network as in the case in which the patch data is output. The downloaded calibration data is stored in the calibration data storing section 21. A downloading command and others in this process are dependent on the command system of the printer 2, but will not be mentioned here.

Fig. 11 is a flow chart showing a process executed by the printer 2 and a process on receiving download data from the server PC 1. At step S70 of Fig. 11, a judgment is made whether the data is received or not. When the data is not received, step S70 is repeated. When the data is received, the data is analyzed at step S71. The analysis result is judged at step S72; when the data is judged to be a calibration download command, the calibration data is stored in the calibration data storing section 21 at step S73 as described above. When the data is judged not to be the calibration download command at step S72, corresponding processes to the judges are carried out at step S74.

Usual print data is sent to the printer 2 from an

application on the PC 1 through a printer driver also on the PC 1. The printer 2 analyzes the print data, composes a page layout, executes an image processing, prints an image and so on at step 74 and others.

Fig. 12 is a flow chart showing, among the above-mentioned processes, the image processing using the downloaded calibration data. First step S110 color fine adjustment is carried out with respect to input signals RGB. The color fine adjustment refers to a brightness correction and a contrast correction. Then at step S111 a color matching processing is executed. The color matching processing is a process carried out to match a color shown by a monitor and a color shown in printing by a printer. Next at step S112 a brightness-density conversion processing is executed. This is a process of converting brightness RGB, which are input signals, to density CMYK, which are print signals for the printer. At step S113 a correction processing is carried out. More specifically, the correction processing has input signals of 8-bit multi-valued signals for respective C, M, Y, K and makes print output characteristics of the printer relative to the input signals linear by using the calibration table data described above. Next at step S114 the 8-bit multi-valued signals for respective C, M, Y, K are converted into signals adapted to an output system. Generally, the 8-bit signals are binarized to be converted to 1-bit signals for respective C, M, Y, K.

Step S88 provides a button for moving to step S89, and if the user presses the button, the processing moves to step S89. Step S89 displays a picture for enabling the measurement data to be saved, and for saving the scan data
5 measured at step S87. The saved file can be used in a process using the existing measurement data described below. When the process of Step S89 is completed, the process returns to step S88. Then at step S810 the process completion picture is displayed. If the user designates
10 the completion of the application on the picture, the process is completed, while if the user designates the return to the main picture, the process returns to step S81.

When the user chooses "Open the measurement data" and
15 presses "Next" on the main picture in step S81, the process proceeds to step S83 and there appears a picture for indicating the measurement data. Here, when the user presses a "reference" button, a picture for reading the measurement data appears at step S86. This picture
20 enables the user to search the measurement data in detail. The measurement data is the data file saved at step S89. Then at step S88 the calibration is applied. The subsequent processes are the same as described above.

When the user selects "Delete the download data" and
25 presses "Next" on the main picture in step S81, at step S84 the calibration data stored in the calibration data storing section 21 of the printer 2 is deleted. This

A second embodiment of the present invention will be described in detail below.

In the above-described first embodiment, even if the standard scanner is used as the object scanner for the scanner calibration, the print system is adapted to execute a process of the scanner calibration. In contrast in this embodiment, if the standard scanner is used as the object scanner, the scanner calibration is skipped and the subsequent steps are executed using a standard scanner brightness-density conversion table generated in advance.

Accordingly, a configuration of the printer calibration in this embodiment is basically the same as in the first embodiment, but differs from the first embodiment in following points. In the embodiment a judgment is made as to whether the scanner for use is a standard scanner or not. When the scanner is judged to be the standard scanner, the step of the scanner calibration is skipped, and then the subsequent steps are executed using the standard scanner brightness-density conversion table generated in advance. Also a control method for the above configuration different from that of the first embodiment.

The different points from the first embodiment will be described below.

Fig. 15 is a flow chart showing a process of a user interface (UI) in a PC 1 of a print system according to the second embodiment of the present invention, and shows

similar process to Fig. 13.

At step S131 a main picture is displayed. Fig. 14 shows an example of the main picture as described above. The processing is basically structured to cause other
5 pictures to appear when buttons "Next," "Return," "Cancel," "Help" shown in Fig. 14 are pressed. The main picture shown in Fig. 14 provides three selection menus of "New," "Open the existing measurement data," "Delete the download data." If "New" is chosen and "Next" is
10 pressed, the process moves to step S132. At step S132 the patch data is output to the printer 2. Then at step S135 a judgment is made as to whether the standard scanner is selected as an object scanner or not at that point. Fig. 16 shows an example of a scanner selection picture. The
15 picture is displayed after the main menu (picture). In Fig. 16 the numeral 141 represents a scanner selection dialogue, and the user can select an arbitrary scanner by means of a pull-down menu 142. In the process of step S135 a judgment is made as to whether the selected scanner is
20 the standard scanner or not based on a name of the selected scanner.

When it is judged that the selected scanner is not the standard scanner, at step S136 the scanner 3 is calibrated by the PC 1 as described above, and the brightness-density
25 conversion table 5F peculiar to the scanner 3 is generated.

On the other hand, when the selected scanner is judged to be the standard scanner at step S135, the process of

step S136 is skipped, and the brightness-density conversion table 5F is loaded from the standard scanner brightness-density conversion table storing section 112 shown in Fig. 1 and is used in the subsequent steps.

5 Then at step S138, as described above, the patch is measured by means of the scanner 3 and the brightness-density conversion table 5F, and at step S139 the calibration is applied.

10 In the second embodiment, the same processes as in the first embodiment are executed except the processes in which a judgment is made as to whether the used scanner is the standard scanner or not, and when the used scanner is judged to be the standard scanner, the step of the scanner calibration is skipped, and then the subsequent steps are
15 executed using the standard scanner brightness-density conversion table generated in advance; thus the description will be omitted.

20 As can be seen from the above description, according to the second embodiment, the scanner calibration step can be skipped when the standard scanner is used as the object scanner, and thereby the efficiency of the processes can be improved.

25 According to the first and second embodiments, it is possible to calibrate a reading means such as a scanner with high accuracy, and to use the reading means as a reading means such as a densitometer, which can detect density with high accuracy.

It is also possible to generate dynamically a brightness-density conversion table for a reading means in the calibration of the reading means so that not only a fixed type of device but all purpose types of apparatus
5 may be employed as the reading means.

In addition, it is possible to reduce burden of the user required for the calibration of a reading means as much as possible.

10 <Third Embodiment>

A third embodiment of the present invention is directed to a configuration that, in the scanner calibration similar to that in the first and second embodiments, if the measurement result, which is obtained
15 by reading the chart shown in Figs. 4A and 4B, is inappropriate for the subsequent generation of the brightness-density conversion table, processes such as doing again of reading are executed.

Fig. 17 is a flow chart showing a sequence of processes
20 of generating the brightness-density conversion table in this embodiment. At step S51 the predetermined patches shown in Figs. 4A and 4B is read by means of the scanner 3 which is an object of the scanner calibration, and thereby brightness signal values are obtained.

25 At step S52 a measurement result obtained in step S51 is displayed as shown in Fig. 18. In order to measure the density with high accuracy by using a scanner as similarly

to a case of using a densitometer, it is necessary to use the input range of the scanner efficiently. If the measurement result is like bad examples shown in Fig. 18, in which output values in a certain range are the same, an effective correction process cannot be carried out for this range. That is, an effective brightness-density conversion table cannot be generated. Thus in order to measure the density with high accuracy by using the scanner as similarly to the case of using the densitometer, it is necessary that the measurement result in step S51 should be like correct examples shown in Fig. 18.

If the color measuring result for each color of C, M, Y, K shown on the left side of Fig. 18 is like bad examples shown on the right side of Fig. 18, in which the output level is the same in a certain input range, the user is advised to redo the process at step S51 in this embodiment.

In the case that the reading result is like bad examples in Fig. 18, it may be possible to improve the reading result by altering the scanner reading conditions such as resolution, color processing conditions, color matching conditions.

Next, at step S53, the standard scanner property obtained by that the scanner calibration patch used at step S51 is measured in advance by means of the standard scanner separately, and the data of the standard scanner brightness-density conversion table are loaded. The data is, as described in the first embodiment, stored in advance

in predetermined memories.

At step S54 based on the brightness signals R, G, B read at step S51 and the standard scanner information loaded at step S53, as described above, a brightness-
5 density conversion table, which is used for reading with use of the scanner on the printer calibration, is generated. This process completes the calibration of the scanner 3.

<Fourth Embodiment>

10 In the first to third embodiments, as described as to Fig. 13, for example, each time calibration for the printer is performed, generation of the brightness-density conversion table by using the scanner calibration patch and the corresponding density data is executed. In
15 contrast in this embodiment, the brightness-density conversion table is prepared in advance for each type of scanner, which may be employed, and the brightness-density conversion table appropriate for the type of scanner used in the system is downloaded and used.

20 Fig. 19 is a block diagram showing a configuration of a print system according to this embodiment.

The configuration of this embodiment is basically the same as the configuration shown in Fig. 1 according to the first to third embodiments. The difference is that in this
25 embodiment there are a plurality of scanner calibration data storing sections in accordance with the type of scanners which the server PC 1 may employ. In the example

and others, but the detail thereof will not be mentioned here.

Then at step S122 the brightness-density conversion table in accordance with the type of scanner specified as
5 above is read from the storing section shown in Fig. 19 and is downloaded.

Thus by preparing in advance the scanner calibration data for the type of scanners which may be used, and in the process of patch reading on the printer calibration
10 by downloading the scanner calibration data corresponding to the scanner for doing the reading and thereby executing the brightness-density conversion. Thereby, it becomes possible to performing reading of the patch where correct reflecting of the patch density can be realized, and to
15 shorten the time required for the scanner calibration process.

Although in the fourth embodiment scanner calibration data is prepared for each type of scanners, this is not the only possibility of the present invention; it is
20 possible to prepare the scanner calibration data for each individual scanner of the same type, for instance.

<Fifth Embodiment>

In this embodiment, the scanner itself possesses the
25 scanner calibration data storing section. Then the calibration data stored in the storing section may be generated each time the printer is calibrated as in the

first to third embodiments, or may be obtained and stored in advance as in the fourth embodiment.

Fig. 21 is a block diagram showing a configuration of a print system according to this embodiment. The system in this embodiment is constituted basically the same as the system shown in Fig. 1 of the first embodiment; the difference is that the scanner 3 stores the scanner calibration data in this embodiment.

In this embodiment too, under control of the server PC 1, the printer 2 is calibrated by the same procedure described as to Fig. 7. The difference is that when the patch is read at step S42, the scanner calibration data is loaded from the storing section 31 of the scanner 3 in this embodiment.

Fig. 22 is a flow chart showing the processes related to the above difference. First at step S141 a judgment is made as to whether the scan is a scan for measuring patch density for the purpose of the printer calibration or not. This judgment can be made based on information such as a command parameter for giving an instruction to execute the scan from the server PC 1, and others, but the detailed description thereof will not be mentioned here.

At step S141 when the scan is judged not to be a scan for measuring a patch, at step S144 usual scan is carried out, and then at step S145 the reading data is transferred to the PC 1. At step S141 when the scan is judged to be the scan for measuring a patch, at step S142 the scanner

calibration data is loaded from the storing section 31 of the scanner 3, and then at step S143 the scan for measuring the patch is carried out using the brightness-density conversion table. Then the data read by this scan is transferred to the PC 1.

According to this embodiment, since the scanner calibration data is stored in the scanner connected to the system, it is possible to omit such processes as the specification of the scanner when the reading is executed.

10 Although the processes related to the calibration such as the generation of the calibration data are executed by the server PC in the above-described embodiments, it is possible to have the applications operate in the client PC and to have the PC execute the processes.

15 And although in the above-described embodiments the calibration table generated in the server PC is transferred to the printer and is used in an image processing of the printer, this is not the only possibility of the present invention. For instance, in the case of a host apparatus
20 such as a server PC generating binarized bit map data, the host apparatus may store a calibration table, for example, a γ table which is calibrated.

<Other Embodiment>

25 The present invention may be applied to a system consisting of a plurality of devices (such as a host computer, an interface device, a reader and a printer) or

to single device (such as a copying machine and a facsimile).

The present invention also includes a configuration in which a computer in an apparatus or system, which is connected with a variety of devices so as to realize functions of the foregoing examples shown in Figs. 2, 3, 11-13, 15, 20 and 22, is loaded with a program code of software and in which these devices are operated according to the program stored in the computer (CPU or MPU).

10 In this case, the software program code itself realizes the functions of these examples. The program code and a means for loading the program code to the computer, such as a storage medium containing a program code, constitute the present invention.

15 The storage media for storing the program code include floppy disk, hard disk, optical disk, magnetooptical disk, CD-ROM, magnetic tape, nonvolatile memory card and ROM.

The program code is included in the present invention not only when the functions of the aforementioned examples are realized by executing the program code loaded into the computer, but also when these functions are realized by the program code in cooperation with an OS (operating system) or application software running on the computer.

It is needless to say that the present invention
25 further includes a configuration in which the program code
is stored in a memory mounted on a computer's function
extension board or a function extension unit connected to

the computer and the CPU in the function extension board or unit executes a part or all of the actual processing according to the instructions of the program code to realize the functions of the preceding examples.